Near real-time air quality forecasts using the NASA GEOS model

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USRA/GESTAR

NASA Global Modeling and Assimilation Office (GMAO)

In collaboration with:

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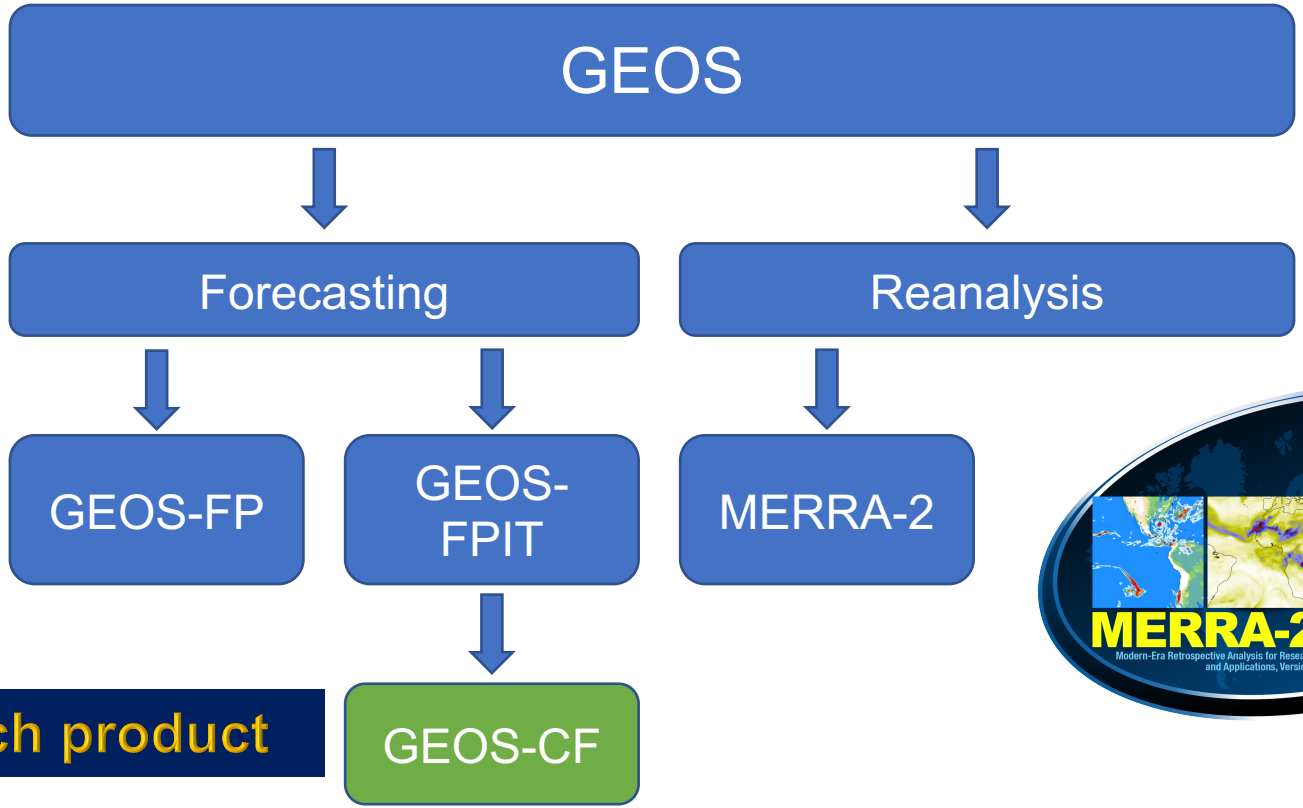
Atmospheric Chemistry and Dynamics Lab: Bryan Duncan, Melanie Follette-Cook, Junhua Liu, Julie Nicely

NASA GMAO global meteorology and chemistry products



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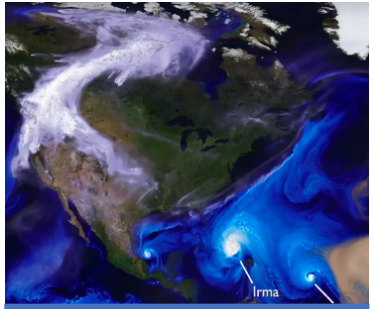
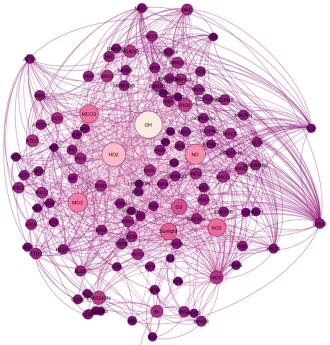
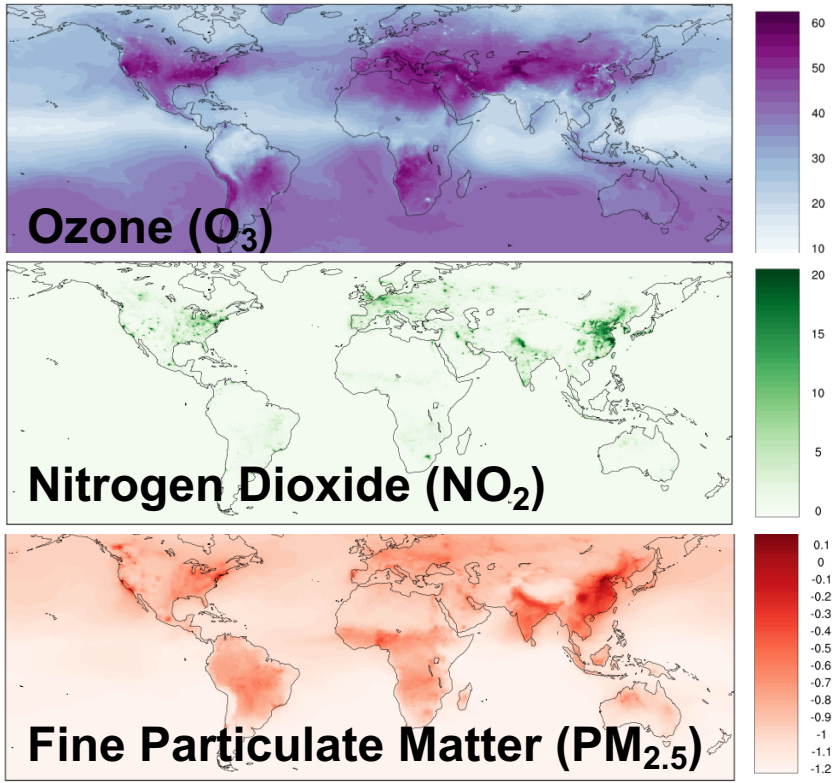
NASA's composition forecast (GEOS-CF)



GEOS FPIT



GEOS - Chem



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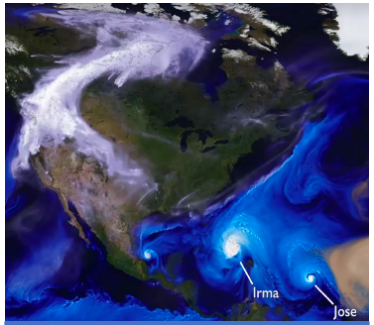
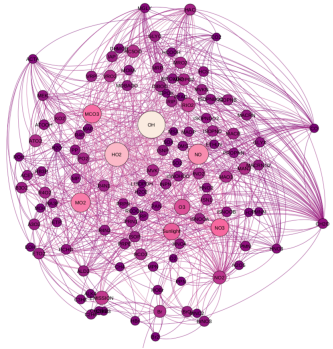
NASA GMAO's Composition Forecast



GEOS NWP

+



GEOS - Chem

Research product

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GEOS-Chem is a state-of-the science chemistry transport model

Tropospheric and Stratospheric full chemistry

- 250 reactive species, 725 reactions
- 100+ user/developer groups worldwide
- Updated version is released about every year

GEOS-Chem

Harvard University
Atmospheric Chemistry Modeling Group

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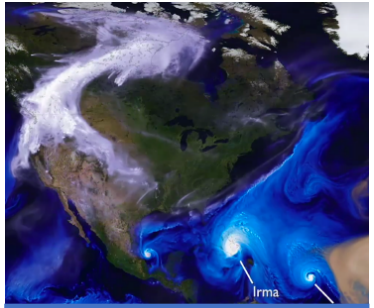
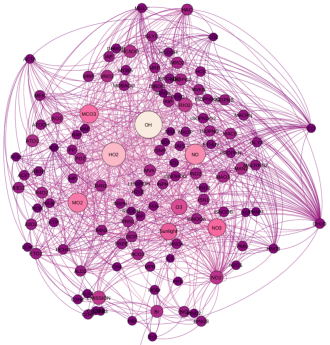
Daily composition forecast



GEOS NWP



GEOS - Chem

GEOS - CF

One **5-day forecast** per day

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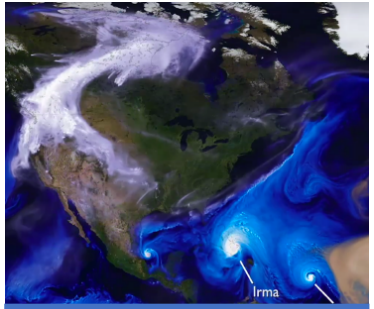
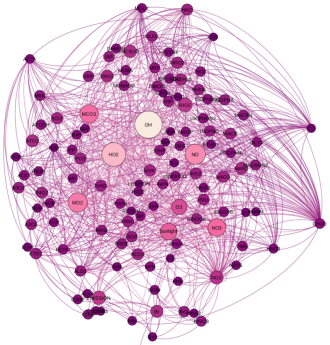
Daily composition forecast



GEOS NWP



GEOS - Chem

GEOS - CF

One **5-day forecast** per day

- 1-day hindcast “analysis”
- 5-day forecast

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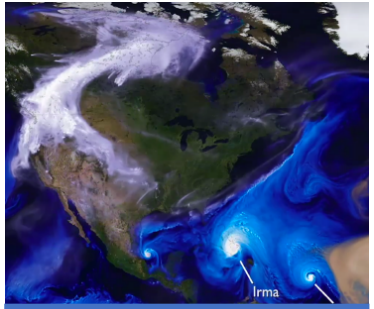
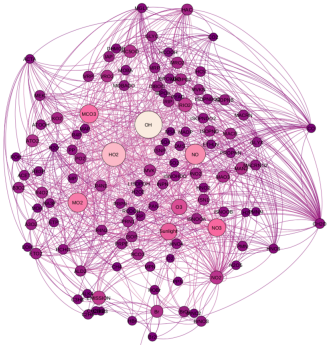
Daily composition forecast



GEOS NWP



GEOS - Chem

GEOS - CF

One **5-day forecast** per day

- 1-day hindcast
- 5-day forecast
- c360 (0.25°, **~25x25 km²**) resolution, 72 model layers

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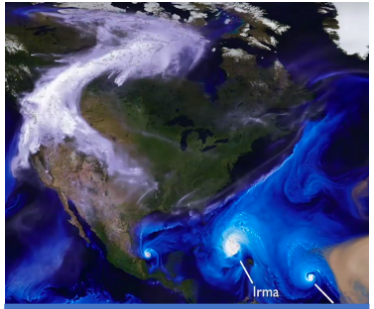
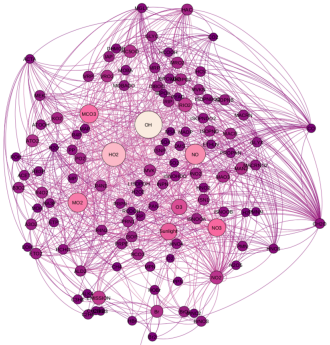
Daily composition forecast



GEOS NWP



GEOS - Chem

GEOS - CF

One **5-day forecast** per day

- 1-day hindcast
- 5-day forecast
- c360 (0.25°, **~25x25 km²**) resolution, 72 model layers
- O_3, NO_x, VOCs, PM ...

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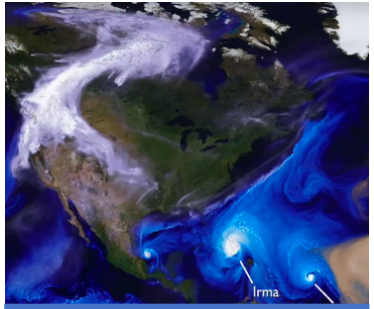
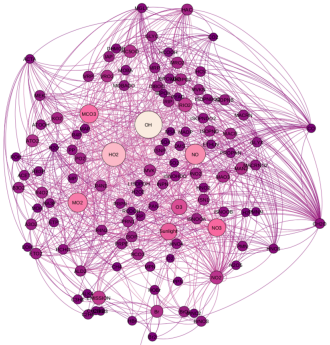
Daily composition forecast



GEOS NWP



GEOS - Chem

GEOS - CF

One **5-day forecast** per day

- 1-day hindcast
- 5-day forecast
- c360 (0.25°, ~25x25 km^2)
- **15 minute** "surface"
- **1-hour** average and instantaneous 2D & 3D

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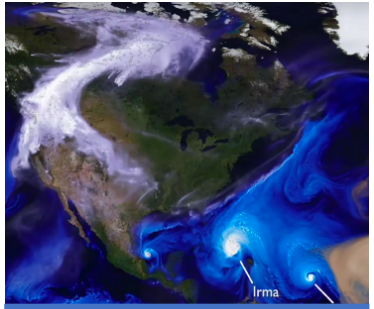
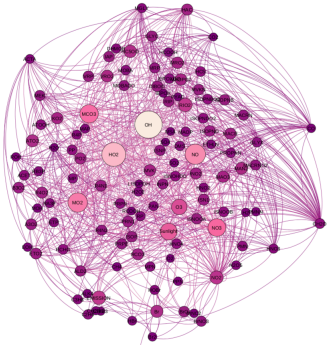
Daily composition forecast



GEOS NWP



GEOS - Chem

GEOS - CF

One **5-day forecast** per day

- 1-day hindcast
- 5-day forecast
- c360 (0.25°, ~25x25 km^2)

- **1 January 2018 - NRT**

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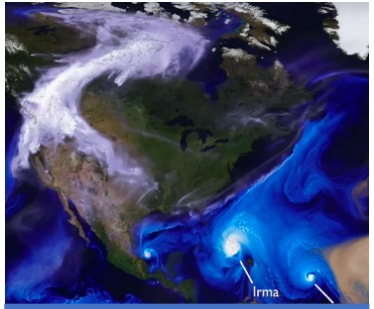
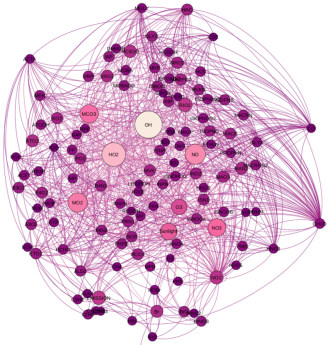
Chemistry is not cheap!



GEOS NWP



GEOS - Chem

GEOS - CF

Run on **NASA's** Center for Climate Simulation **supercomputer**

- using the computing power equivalent to **3500** personal **computers**.

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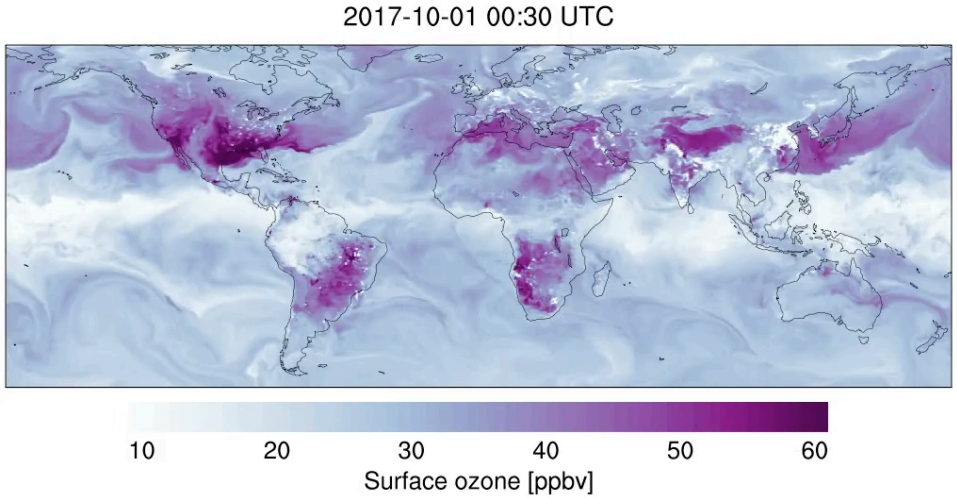
High-Resolution Global Simulation

GEOS - CF



25 km x 25 km (16 miles)

- **Highest** horizontal resolution of a global atmospheric composition forecast
- **10 x higher** than conventional global atmospheric chemistry simulations.

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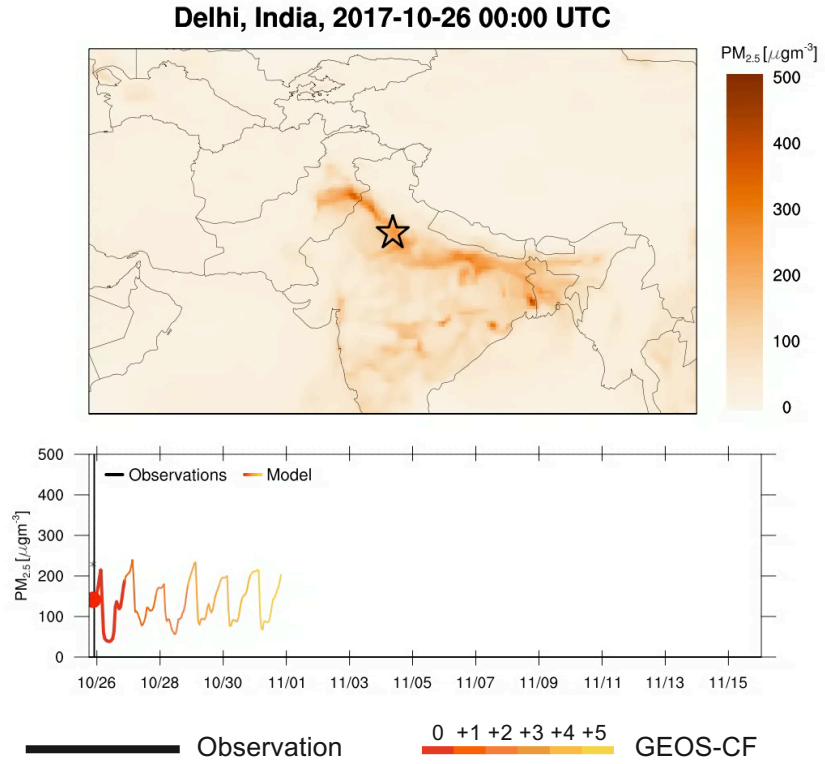
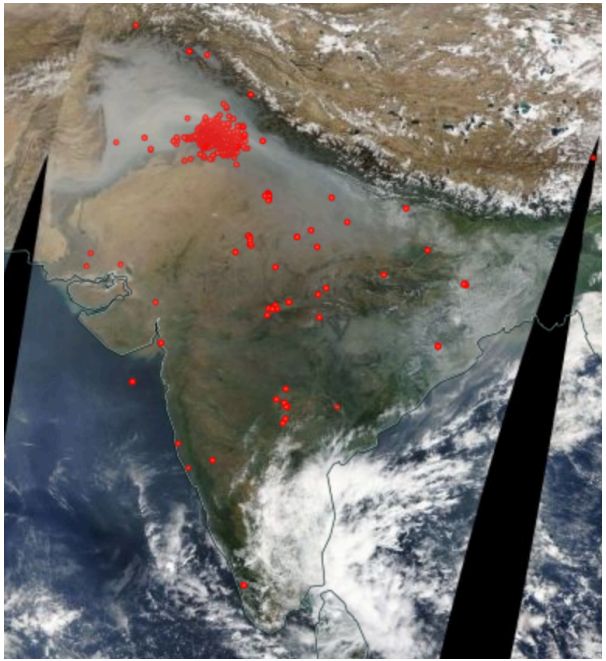
Case study: agricultural fires in India



MODIS fires Nov 01, 2017



openaq

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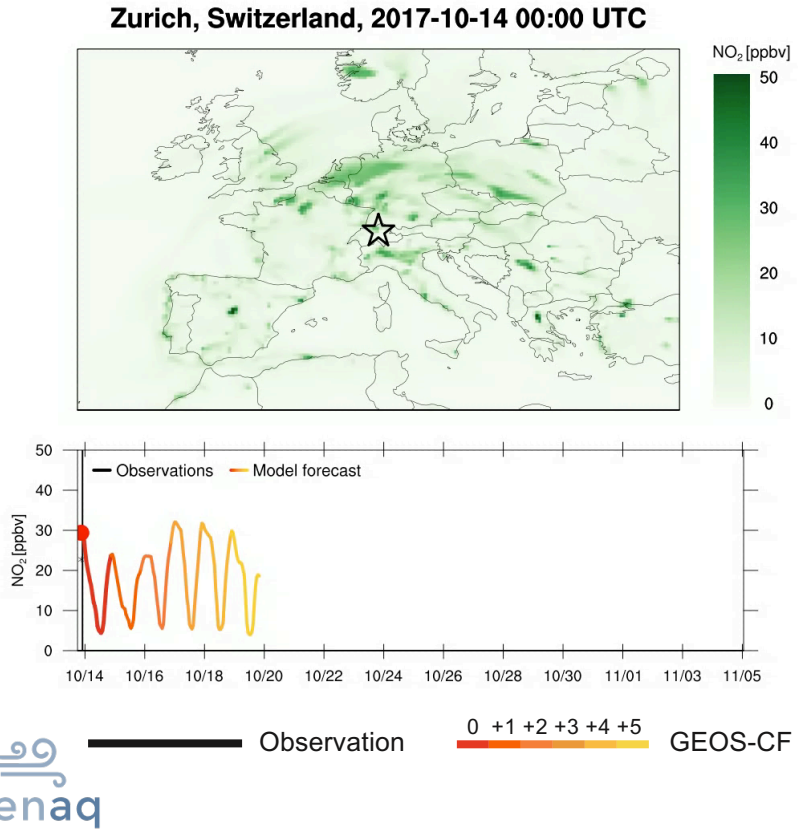
Daily composition forecast



openaq

GEOS - CF

- Annual emission scale factors based on satellite
- Scale factors applied to emissions for diurnal and weekly variations

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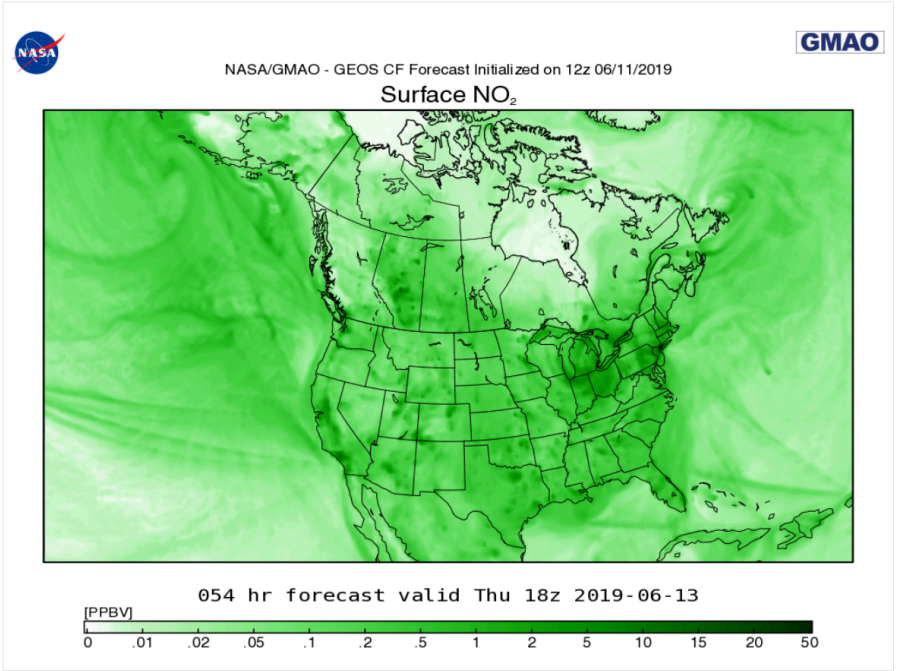
Where to find GEOS-CF

Output available at fluid.nccs.nasa.gov/cf



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Composition Forecast Maps

FIELDS

CO Sfc | NO2 Sfc | O3 Sfc | PM2.5 Sfc | SO2 Sfc

REGIONS

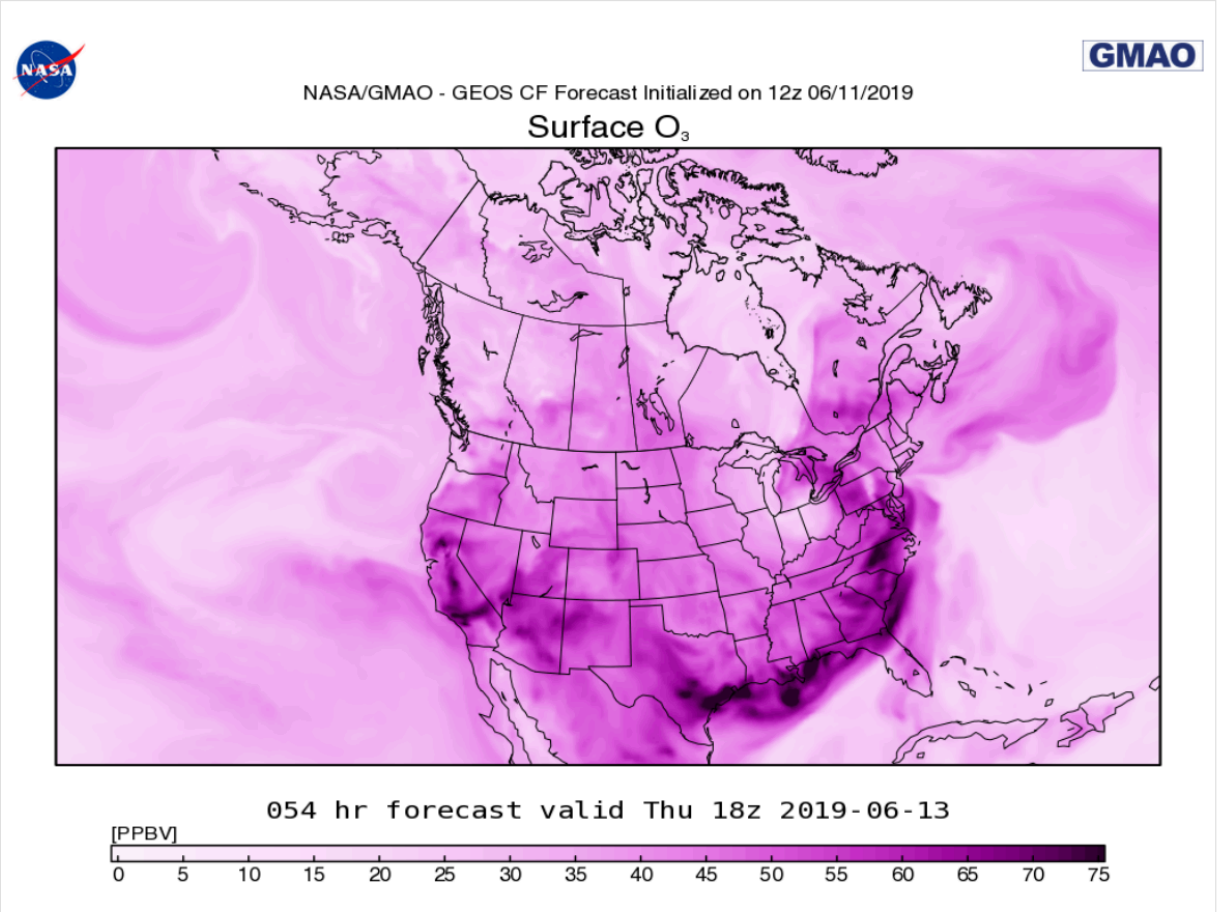
North America

FORECAST INITIAL TIME

11Jun2019 12z

FORECAST LEAD HOUR

054h 13Jun2019 18z



Model forecast O_3

https:/fluid.nccs.nasa.gov/cf

Model forecast O_3 at Raleigh

Composition Forecast

CF Datagrams

NATIONAL

Raleigh

WORLD

Select a Station

AERONET

Select a Station

MEGACITIES

Select a Station

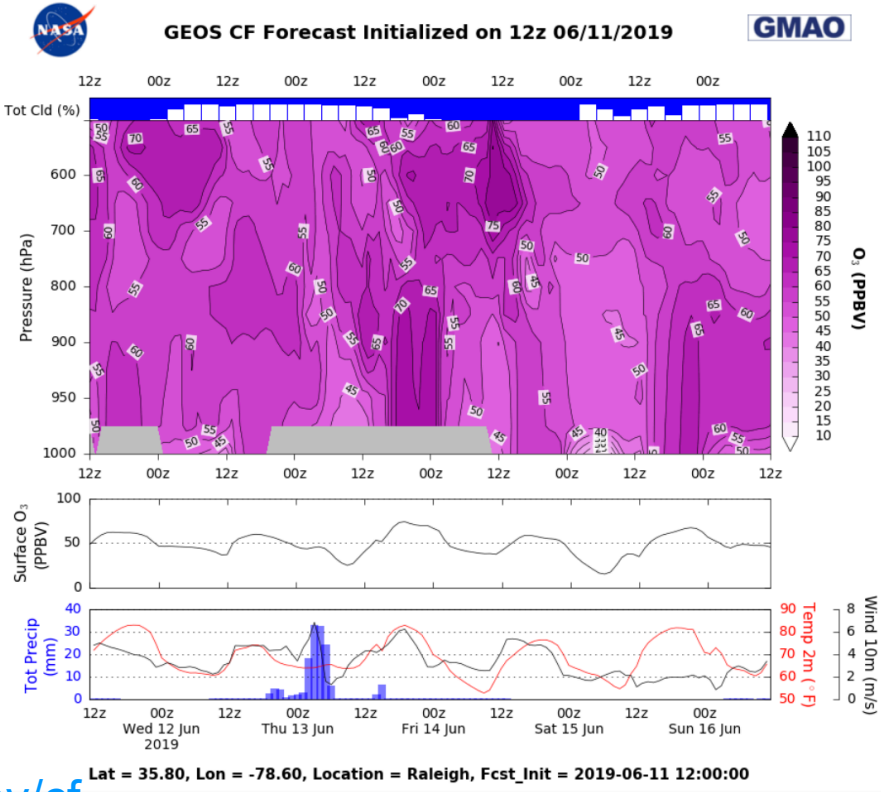
ACTIVE CAMPAIGNS

Select a Station

GMAO GEOS CF Datagrams

O3 at Raleigh (35.80, -78.60)

CO | NO_2 | **O_3** | PM 2.5 | SO_2



Vertical O_3

Surface O_3

Meteorology

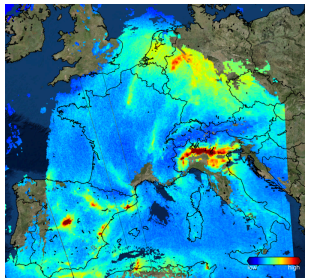
https:/fluid.nccs.nasa.gov/cf

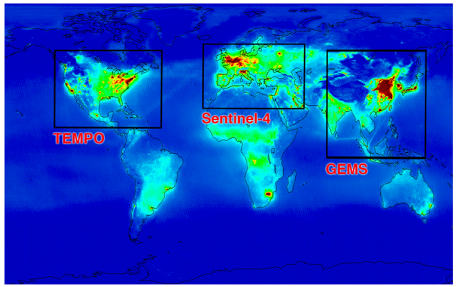
Summary

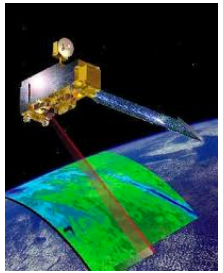
- GEOS-CF produces daily global air quality forecasts at 25km (16 miles) horizontal resolution
- Output available at fluid.nccs.nasa.gov/cf

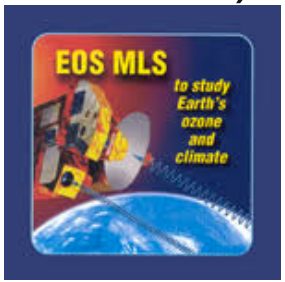
Under development:

- Assimilation system for trace gases (O_3, NO_x, CO, & others)









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IIEC
International Institute for Energy Conservation


HAQAST


developmentSEED


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VE RI TAS
HARVARD


FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE


openaq


unicef


QUITO
ALCALDÍA

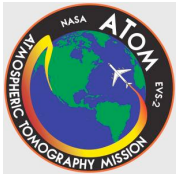

NOAA
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE


CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION


JAYA RAYA


BMKG


C40
CITIES
CLIMATE LEADERSHIP GROUP


NASA
ATOM
ATMOSPHERIC TOMOGRAPHY MISSION


CLIMATE &
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COALITION
TO REDUCE SHORT-LIVED
CLIMATE POLLUTANTS


HawaDawa


APHC
ARMY PUBLIC HEALTH CENTER


BOEM & NASA
SATELLITE COASTAL AND OCEANIC ATMOSPHERIC POLLUTION EXPERIMENT
SCOAPE


KNMI


JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH


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GOVERNO DO
Rio de
Janeiro


IBM

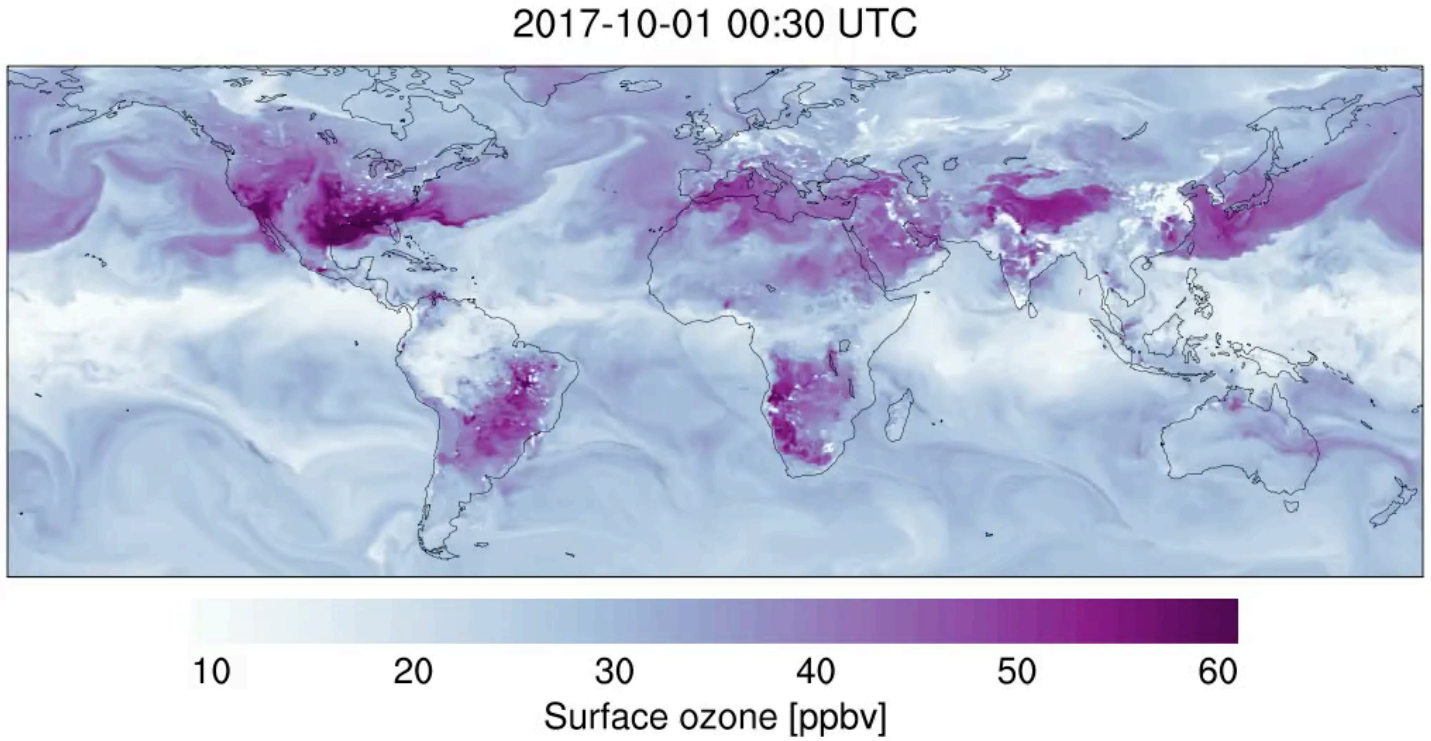

Swiss Re


DEPARTMENT OF STATE
UNITED STATES OF AMERICA


ECMWF


WORLD
RESOURCES
INSTITUTE

Thank you!



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